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Aquafeeds

Selective breeding represents a fresh hope for microalgae as a feed ingredient

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By Bonnie Waycott

Nofima researchers determine that selective breeding yields faster-growing microalgae that produce more omega-3s

Nofima researchers find that selective breeding yields faster-growing microalgae that produce more omega-3 fatty acids crucial to aquafeeds. Pictured is Nofima researcher Marie Lillehammer. Courtesy photo.

As the global demand for seafood rises, the traditional reliance on fish-based feed for aquaculture is posing significant environmental challenges. Scientists believe that microalgae is a promising solution, due to the vast number of species – **more than one million strains** (https://www.sciencedirect.com/science/article/abs/pii/S221192641830198X) are thought to exist in nature – and the compounds they contain, such as proteins, fatty acids and colorants.

With this in mind, researchers at Nofima, Universidad de Las Palmas and Ghent University decided to investigate whether selective breeding could help microalgae grow faster and produce more omega-3 fatty acids. Their research is part of the project **NewTechAqua** (https://www.newtechaqua.eu), which aims to develop and validate technological advances and applications to expand and diversify European finfish, mollusk and microalgae production.

“Microalgae are promising, but their larger-scale use is challenging because production costs are higher than other competing ingredients,” Marie Lillehammer, senior scientist at Nofima, told the *Advocate*. “We wanted to see if we could develop cultivated strains of microalgae that are tailor-made for a particular use and production environment.”

Lillehammer and her team chose the species *Seminavis robusta*, a heterothallic alga that reproduces sexually as part of its natural life cycle. Although not the most relevant source of feed, it is a typical research species that is often used in laboratories and was the easiest to manage during tests on sexual reproduction, according to Universidad de Las Palmas. Eight lines of the species were crossed with each other in one generation and tested in the breeding experiment.

Most traits to improve during breeding programs can be split into three categories: growth (a species' production efficiency), composition (protein and fat content) and robustness (disease resistance and the ability to adapt to certain environments). In this study, growth and fatty acid composition were included. For later studies, exploring other composition and robustness traits will be relevant, says Lillehammer.

"The program begins by ranking potential parents, selecting the best ones and crossbreeding them to produce the next generation," she said. "Crossbreeding, a natural way of recreating genetic variation, is not that straightforward, because some strains are not necessarily compatible due to mechanisms that prevent them from interbreeding with strains that are very different to themselves. We ended up with some non-compatible strains in the beginning that could not be crossed. Still, we were able to set up an experiment that allowed us to estimate the genetic variation in traits of interest. We found that 18 percent of omega-3 production in *S. robusta* is determined by genes, which could yield 8.8 percent improvement from one generation of selection, if 20 percent of potential parents are selected."

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For growth, Lillehammer and her team expect that with an inheritance rate of 50 percent, *S. robusta* would grow 25 percent faster per generation. In theory, this is a ninefold increase per year, given 10 generations in one year. Because there is genetic variation in microalgae, their composition can be

altered by selecting and crossing the best strains. This accumulated response over generations is obtained without any genomic modification. But more research will be required in areas such as physiological limitations that could halt growth over generations and any side effects of growth.

“For commercial production, we will not be able to rely on selective breeding alone to produce the best possible strains,” said Lillehammer. “We will need to optimize the growth environment and culturing conditions as well. One difference between microalgae and many other organisms that are bred selectively is the very short generation interval. For example, we could carry out multiple rounds of selection without finding out how these cultures would survive over a longer period. When huge progress is made over a short period of time, it’s important to monitor any unwanted side effects, not because we expect them to be severe, but because we don’t know anything about them.”

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Lillehammer and her team say that the selective breeding of microalgae should be explored further if microalgae is to become an important aquafeed ingredient in the future. Selectively breeding other microalgae species with strong potential as aquafeed ingredients and comparing their growth in large-scale conditions will be the next steps, as well as establishing ways to measure growth to ensure production in a more commercial-like environment.

“We only measured growth and fatty acid composition in laboratory conditions using very small amounts over a very short period of time,” said Lillehammer. “We can selectively breed microalgae and make them grow faster, but we don’t know if the strains that grow fastest in a lab will grow fastest in commercial conditions. We are still in the testing stage and proving that our research works but it’s extremely inspiring and I believe that it will make a difference when it comes to using microalgae as an aquafeed ingredient.”

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Correspondent Bonnie Waycott became interested in marine life after learning to snorkel on the Sea of Japan coast near her mother's hometown. She specializes in aquaculture and fisheries with a particular focus on Japan, and has a keen interest in Tohoku's aquaculture recovery following the 2011 Great East Japan Earthquake and Tsunami.